

CLAIMS

What is claimed is:

1. A method of making an anisotropic electrically conducting layer, which has a globally ordered crystalline structure, the method comprising:
 - 5 forming an anisotropic crystalline layer by means of Cascade Crystallization Process, wherein said anisotropic crystalline layer is characterized by the globally ordered crystalline structure with the intermolecular spacing of $3.4 \pm 0.3 \text{ \AA}$ along the polarization axis of said layer, and formed by rodlike supramolecules, which comprise at least one polycyclic organic compound with conjugated π -system and ionogenic groups; and
 - 10 applying an external influence upon the anisotropic crystalline layer to remove the ionogenic group from the anisotropic crystalline layer, wherein the duration, character and intensity of the external influence are selected so as to ensure a partial removal of part of the ionogenic groups from the anisotropic crystalline layer while retaining a crystalline structure after
 - 15 termination of the external influence.
2. The method according to claim 1, wherein the external influence is applied by a local or complete heating of the anisotropic crystalline layer to a pyrolysis temperature.
3. The method according to claim 2, wherein the heating is conducted by one or several
20 means selected from the group consisting of microwave radiation, concentric electrical heaters, resistive heaters, an alternative electric field, and alternative magnetic field, and a flow of heated liquid and/or gas.
4. The method according to claim 1, wherein the external influence is applied by treating at least part of the anisotropic crystalline layer by microwave and/or laser radiation having a
25 frequency in resonance with at least an absorption band of the organic compound.
5. The method according to claim 1, wherein the ionogenic groups are selected from the group consisting of sulfonic groups, COO^- , PO_4^- , cation groups, and carboxy groups which are ionogenic groups used for imparting amphiphilic properties to the organic compound.

6. The method according to claim 1, wherein at least one anisotropic crystalline layer is formed on a substrate.
7. The method according to claim 6, wherein the substrate has a flat, convex or concave surface.
- 5 8. The method according to claim 6, wherein the external influence is applied by heating up the substrate.
9. The method according to claim 1 or 6, wherein first at least one layer of an additional electrically conducting material is formed on the substrate and further the anisotropic
10 crystalline layer is formed on said additional electrically conducting layer.
10. The method according to claim 1 or 6, wherein first at least one said anisotropic electrically conducting layer is formed on the substrate and further the anisotropic crystalline layer is formed on the top of the anisotropic electrically conducting layer.
- 15 11. The method according to claim 1, wherein the external influence is applied in an atmosphere of buffer gas.
12. The method according to claim 11, wherein the buffer gas comprises He, Ar, Xe and any other inert gas, N₂, CO₂, and any other non-reactive gas.
13. The method according to claim 1, wherein the organic compound further comprises at
20 least one dopant substance and/or a compound which does not break the flat structure of the molecules or fragments of the molecules of the lyotropic liquid crystal organic compound and changes the type and size of the electrical conductivity of the anisotropic electrically conductive layer.
14. The method according to claim 1, wherein the organic compound further comprises at
25 least one dopant substance and/or compound which does not break the flat structure of the molecules or fragments of the molecules of the lyotropic liquid crystal organic compound and creates centers of an emitting electron-hole recombination with emission of quanta of light in one or several of the spectral regions including infra-red, visible and ultra-violet

spectral regions.

15. The method according to Claim 1, wherein the organic compound used for preparing a lyotropic liquid crystal comprises at least one aromatic compound with the general structural formula



where K is a dye, the structure of which contains one or more ionogenic groups, either same or different, ensuring the solubility in polar solvents for the formation of a lyotropic liquid crystal phase; M is a counterion; and n is the number of counterions in the dye molecule, which can be fractional if the counterion is shared among several molecules.

10 16. An organic light-emitting device, comprising:

a substrate; and

an organic electroluminescent cell formed on the substrate,

wherein said organic electroluminescent cell comprises:

a first electrode that serves as an anode;

15 a second electrode that serves as a cathode; and

at least one light-emitting layer located between the anode and cathode,

20 wherein the at least one of the light-emitting layers is an anisotropic electrically conducting layer, which has a globally ordered crystalline structure with an intermolecular spacing of $3.4 \pm 0.3 \text{ \AA}$ in along the polarization axis of said layer, is formed by rodlike supramolecules, which comprise at least one polycyclic organic compound with conjugated π -system and ionogenic groups.

17. The organic light-emitting device according to claim 16, wherein at least one layer of the organic electroluminescent cell is simultaneously electron transporting and light-emitting.

25 18. The organic light-emitting device according to claim 16, wherein at least one layer of the organic electroluminescent cell is simultaneously hole transporting and light emitting.

19. The organic light-emitting device according to claim 16, wherein at least one layer of

the organic electroluminescent cell is simultaneously light-emitting and both electron- and hole transporting.

20. The organic light-emitting device according to claim 16, wherein the organic electroluminescent cell further comprises an electron transporting layer located between the cathode and the light-emitting layer and/or at least one hole transporting layer located between the anode and the light-emitting layer.

21. The organic light-emitting devices according to claim 16, wherein at least one light-emitting layer of the organic electroluminescent cell is formed using one of organic compounds selected from the group consisting of indanthrone (Vat Blue 4), or 1,4,5,8-naphthalene tetracarboxylic (PTCDA), bis-(1,2,5-thiadiazolo) - p-quinobis-(1,3-dithiol) (BTQBT), aluminum dibenzoimidazol (Vat Red 14), 3,4,9,10-pyrylenetetracarboxylic dibenzoimidazol, or hinakridon (Pigment Violet 19), and 3,4,9,10-pyrylenetetracarboxylic dianhydride tris (8-hydroxyquinoline) (Alq3).

22. The organic light-emitting device according to claim 16 wherein at least one light-emitting layer of the organic electroluminescent cell is formed using at least one phthalocyanine selected from the group consisting of metal-free phthalocyanines (H_2Pc), phthalocyanines with monovalent or divalent metal, phthalocyanines with metal halide or metal hydroxide, phthalocyanines with tetravalent metals, and phthalocyanines, in which the central ion of metal is replaced or which are substituted by sulfonic acid (or amide), carboxylic acid, alkyl, aryl, halide, or nitro.

23. The organic light-emitting device according to claim 16, wherein at least one light-emitting layer of the organic electroluminescent cell is formed using at least one organic compound or their mixtures selected from the group consisting of different pigments, 3,3'-dichlorobenzidine, 2,7-diaminofluorenone, 2,6-diaminoanthraquinone, 2,7-diaminoanthraquinone, (p-aminophenyl) phenylamine, tris (p-aminophenyl) amine, 2,7-diaminodibenzothiophene sulfone, 2,7-diaminodibenzothiophene, 2-(p-aminophenyl)-6-aminobenzoxazole, bis (p-aminophenyl) amine, N-methylbis (p-aminophenyl) amine, 2,5-bis (p-aminophenyl)-1,3,4-oxadiazole, 1,6-diaminopyrene, and 1,5-diaminonaphthalene.

24. The organic light-emitting device according to claim 20, wherein at least one hole transporting layer of the organic electroluminescent cell is formed using a mixture of triphenylamine tetramer and 0.1-10% solution of 5, 6, 11, 12-tetraphenylnaphthacene or of 9, 10 - diphenylanthracene.
- 5 25. The organic light-emitting device according to claim 20, wherein at least one hole transporting layer of the organic electroluminescent cell is formed using 4,4 '-bis-[(1-naphthyl)-N-phenylamino]-bi-phenyl or N, N '-diphenyl-N, N '-bis (3-methylphenyl) 1-1'biphenyl-4,4'diamine.
- 10 26. The organic light-emitting device according to claim 20, wherein the at least one hole transporting layer of the organic electroluminescent cell is made from a material selected from the group of aromatic tertiary amines.
27. The organic light-emitting device according to claim 16, wherein the cathode is made of a material with a small work function of electrons.
- 15 28. The organic light-emitting device according to claim 27, wherein the cathode is nontransparent and made of any material of the list including aluminum, silver, gold, and alloys of Ca/Al, Mg/Ag and Li/Al.
29. The organic light-emitting device according to claim 16, wherein the anode is made of a material with large work function of electrons.
- 20 30. The organic light-emitting device according to claim 29, wherein the anode is transparent and made of ITO.
31. The organic light-emitting device according to claim 16, wherein the substrate is transparent or nontransparent, hard or flexible, made of any material selected from the group consisting of glass, quartz, plastic, metal and semiconductor.
- 25 32. The organic light-emitting device according to claim 16, wherein the substrate has a flat, convex or concave surface.
33. The organic light-emitting device according to claim 16, wherein the substrate has

anisotropic properties, at least on part of the surface, which are caused by either chemical bonds, or the relief or the texture formed on the surface of the substrate either from the material of the substrate itself or from the material, applied on the surface of the substrate.

34. The organic light-emitting device according to claim 16, wherein the substrate is
5 made of any material selected from the group consisting of aluminum, cobalt, copper, molybdenum, nickel, platinum, tantalum, and their alloys.

35. The organic light-emitting device according to claim 16, wherein the substrate is made of any material selected from the group consisting of polymeric material, glass, metal, ceramics, metal ceramics, and any combination thereof.

10 36. The organic light-emitting device according to claim 20, wherein the organic electroluminescent cell further comprises a highly absorbing and low reflective layer located between the cathode and the electron transporting layer.

37. The organic light-emitting device according to claim 36, wherein the highly absorbing and low reflective layer is made of electrically conductive materials having a work function
15 less than 4.0eV, and substantially black in bulk form and made of any one or several materials selected from the group consisting of calcium hexaboride (CaB_6), lanthanum nitride (LaN), and zinc oxide (ZnO).

38. The organic light-emitting device according to claim 20, wherein the organic
20 electroluminescent cell further comprises an inorganic resistive layer located between the anode and the hole transporting layer.

39. The organic light-emitting device according to claim 38, wherein the inorganic resistive layer is formed of a material selected from the group consisting of amorphous
25 silicon, amorphous indium/tin oxide, amorphous indium/zirconium oxide, and a thin film resistive layer having a sheet resistance between 10^3 ohms/cm² to 10^8 ohms/cm².

40. The organic light-emitting device according to claim 16, wherein at least one light-emitting layer of the organic electroluminescent cell is formed of polymeric organic light-

emitting host material selected from the group consisting of polyparaphenylene vinylene (PPV), PPV copolymers, polyanilines, poly-3-alkylthiopenes, poly-3-octylthiopenes, and polyparaphenylenes.

41. The organic light-emitting device according to claim 40, wherein at least one light-emitting layer of the organic electroluminescent cell is formed of an organic substance comprising a fluorescent dye selected from the group consisting of coumarin, dicyanomethylenepyrans, thiopyrans, polymethine, oxabenzanthracene, xanthene, pyrylium and thiapyrylium, carbostyryl, and perylene fluorescent dyes.

42. The organic light-emitting device according to claim 20, wherein the organic electroluminescent cell further comprises a bi-layer structure, which is formed from an organic material sublayer and a metal sublayer and said bi-layer structure is located between the light-emitting layer and the electron transporting layer.

43. The organic light-emitting device according to claim 42, wherein the organic material sublayer is formed in contact with the organic light-emitting layer and is made of any material selected from the group consisting of an alkali fluoride, lithium fluoride, sodium fluoride, potassium fluoride, rubidium fluoride, and cesium fluoride.

44. The organic light-emitting device according to claim 42, wherein the metal sublayer is made of aluminum and formed in contact with the electron transporting layer.

45. The organic light-emitting device according to claim 20, wherein at least one organic electroluminescent cell further comprises a hole-injection enhancement layer located between the hole transporting layer and the anode.

46. The organic light-emitting device according to claim 45, wherein the hole-injection enhancement layer is formed of 3,4,9,10-perylenetetracarboxylic dianhydride or bis (1,2,5-thiadiazolo)-p-quinobis (1,3-dithiole).

47. The organic light-emitting device according to claim 16, wherein the substrate and the electrode closest to said substrate are transparent.

48. The organic light-emitting device according to claim 16, wherein the substrate is

substantially opaque and the electrode the most distant from said substrate is transparent.